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ABSTRACT

The author enters the debate on whether problem solving ability consists of sets of situation-specific behaviors or whether it is a general set of mental abilities. The study, utilizing a nonrandom sample of 60 female college sophomores, was designed to test the feasibility of teaching behavior patterns which facilitate problem-solving in diverse situations. A basic model was used which included problem sensing, problem defining, hypothesizing, searching for information, and resolving. Differences between experimental and control groups show that problem-solving skill training does facilitate problem solving. In addition, some support is given to the position that training in general problem-solving skills results in a person's being able to better solve problems in diverse situations. The author concludes that it might be more effective to teach inquiry as a set of abstract routines which function to support and enhance mental processing in a wide range of fields. (TL)

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TRAINING AND TRANSFER OF PROBLEM-SOLVING

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Problem-solving ability as a special case of logical thinking has been considered by researchers alternately as a set of behaviors which are specifically learned or which are inherent to most humans and develop over an extended period of time. The emphasis of the latter position has been study of the development of the process through the interactions between the developing individual and his environment. Emphasis on the former often is reflected in a concern for facilitating the acquisition of these skills and processes or, as in the present study, for teaching strategies to adults for improving their effectiveness in problem-solving.

Among those who approach problem-solving as a set of learned strategies or behaviors there is disagreement over the nature of the ability itself. Some writers have considered problem-solving to be sets of situation-specific behaviors. For them it is practical to consider teaching effective problem-solving techniques only within the constraints of the general problem structure. Thus, problem solving in a field such as law would be fundamentally different from problem solving in teaching or medicine. Problem-solving facility is considered an area of knowledge embedded within the structure of disciplines and it is not applicable when learned in abstraction. Others have considered problem-solving as a general set of mental abilities so pervasive that one's ability to solve problems is not principally a function of the situational structure, but rather it is a function of the person's mastery of these general mental processes.

The primary purpose of this study was to test the feasibility of facilitating application of these abstract cognitive processes in complex, structionally different situations by short-term strategy training. The basic model used in the experiment was derived from classic writings on problem solving and inquiry (Dewey, 1938), theoretical writing on the acquisition of problem-solving skill (Thorndike, 1950), research on the training of equipment

troubleshooters (Bryan, 1962) and studies of inquiry in teaching situations (Shulman, 1965; Shulman, Loupe, and Piper, 1968). The model included the following: problem sensing, problem defining, hypothesizing, searching for information, and resolving. The sequence was not thought to be invariable, rather it was an abstraction of processes interconnected with feedback loops and probably occurring in total only under ideal circumstances.

This report addresses two questions which are related to the above conception of problem-solving and inquiry:

(1) Can these abstract processes be facilitated by teaching a series of behaviors which would function as supports for the cognitive processes involved in problem-solving?

(2) If problem-solving can be so facilitated, can transfer to different situations structurally different from the training setting be demonstrated or is the process situation specific as has been suggested by some researchers?

METHODS

This study was one phase of a larger research project evaluating the effects of skill training, personality and openness on inquiry effectiveness. The research reported here dealt only with training in problem-solving skills. Thus some of the variables and dimensions on which subjects were selected will not be discussed in the results.

The basic research design was as follows: Subjects were selected for a complex characteristics thought to facilitate or inhibit effectiveness in inquiry. Within the selection categories, subjects were assigned to one of three training groups, problem-solving skill training, personal openness training, and an unrelated control training. (The purpose of the openness training was to increase the commitment of the subjects to engage in inquiry

(Piper, 1968) and will not be discussed here.) Immediately following training all Ss were given a problem-solving test. Within 5 days of training each subject participated in the Teacher's Inbasket (Shulman, 1965) during which a number of aspects of problem-solving behavior were recorded. Trained Ss were compared with controls on the problem-solving test as well as on the observed aspects of problem-solving behavior.

SUBJECTS

Sixty college sophomore females were selected out of a pool of approximately 400 to represent extreme types of a personality dimension called seeking-style (Shulman, 1965). Screening tests were administered and Ss were selected for composite profiles either high or low on Word Association fluency, Preference for Complexity, Political Liberalism, and Belief Nonstereopathy. The relationships between seeking-style and the dependent measures of inquiry will not be explored here but it is important to know that the sample was not of random composition.

TRAINING

A three-hour, small group training program was devised to illustrate and provide opportunities for practice and reinforcement of behaviors which support the five aspects of inquiry described above. Sherlock Holmes mysteries were used as expert examples and were also segmented to provide information and situations about which Ss were to generate hypotheses, plan search strategies, redefine problem situations, revise search plans, evaluate new information and decide whether a resolution was reached or a new hypothesis needed to be tested. Other problem situations were constructed in the form of branching programs which were used as group training exercises and as individual problem-solving post tests. A trainer led each group insuring participation by all Ss, providing examples and reinforcement and maintaining a quick pace. Control Ss

experienced a 3 hour small group training course in concept learning.

TRANSFER

Within 5 days of training Ss participated in Shulman's Teacher's Inbasket, a simulation of a realistic teaching situation without students present but including all records, communications and the Inbasket of jobs to be accomplished. Ss were instructed to role-play, to do as they would do in a real situation and typically remained in the situation about 2 hours (mean time = 129 min., SD = 32).

DEPENDENT VARIABLES

Ss were observed through one-way mirros while in the Inbasket situation and the following aspects of their behavior were recorded: Bits, the number of times S consulted source material; Sources, the mean number of different kinds of information sources consulted regarding a particular problem; Shifts, the number of times S changed from one source to another; Problem Sensitivity, the total number of problems identified by S; Competence, a qualitative evaluation of the understanding demonstrated by S regarding the problem; Total Time; and Problem-Solving Quality, a competence measure on the immediate training post-test.

SPECIFIC HYPOTHESES

The experimental group trained in problem-solving will exceed the group receiving control training on the following measures: Problem-solving Quality, Problem Sensitivity, Competence, Sources, and Shifts.

RESULTS

MEANS AND STANDARD DEVIATIONS ON SELECTED VARIABLES COMPARED FOR THE PROBLEM-SOLVING AND CONTROLS GROUPS**

		Problem-solving N=20	Control N=20	t	p
P.S. Quality	Mean	4.45	3.45	2.04	.025
	S.D.	1.67	1.43		
Mean Sources	Mean	6.27	5.61	1.82	.10*
	S.D.	1.07	1.22		
Shifts	Mean	137.10	113.25	1.66	.20*
	S.D.	48.39	42.04		
Problems	Mean	78.65	75.50	.63	.80*
	S.D.	14.90	16.61		
Mean Competence	Mean	2.90	2.74	4.52	.002*
	S.D.	.34	.26		

*Because these tests are not orthogonal with a similar set of comparisons found in Piper (1969), the reported probabilities have been adjusted to the maximum, 2 x alpha. To the degree that the tests are independent of those in Piper, the actual probabilities are reduced.

**These tests are one-tailed because the hypotheses are directional.

First, the problem-solving group exceeded the control group in quality of problem solution on the immediate post test ($t = 2.04$, $p < .025$) thereby demonstrating a short term gain in problem solving ability as a result of process training. Second, the experimental group exceeded the control group on two of the dependent measures observed on the transfer task; Sources, a measure of breadth of inquiry ($t = 1.82$, $p < .10$) and Competence, the quality or depth of solution ($t = 4.52$, $p < .002$). There were no differences in Problem Sensitivity or Shifts, although such differences had been expected. As expected, there were no differences between groups in Bits or Time.

DISCUSSION

This study was designed to test the feasibility of teaching behavior patterns which would facilitate problem-solving or inquiry in diverse situations. The subjects were young adults who presumably had established, though unsystematic, patterns of problem-solving. The differences between experimental and control groups on the immediate post test showed that this training had succeeded in facilitating problem-solving. But the more important question was whether problem-solving skills would transfer to a structurally different situation. Thus Ss were observed working in the Teacher's Inbasket situation and a number of aspects of their inquiry behavior were observed. Some of the measures such as Bits and Time were related to the commitment or desire of the individual to inquiry or solve problems (the greater the commitment, the longer S would remain in the situation). Because the training described here was oriented only toward improving skill in problem-solving it was not expected that there would be differences in Bits and Time which were only indirectly related to the quality of inquiry.

The training emphasized definition of the problem in terms of the information available, generation of multiple explanatory hypotheses, formalization of testing plans and redefinition of the problem in light of new information. These strategies were thought related to the behaviors described as dependent variables in the hypotheses and observed in the Inbasket situation, ie., use of a wide variety of information sources during search, comparing and contrasting different sources of information (Shifting), sensing more problems, and resolving problems with more complete understanding of the dynamics of the problematic situation. The results indicated that these predictions were partially substantiated. The training in problem-solving strategies was effective in modifying at least one aspect of problem-solving behavior, use of Sources. This indicated a greater breadth of search for the experimental group

which resulted in facilitating inquiry even though the structure and content of the situations differed. The outcome was reflected in greater overall problem-solving competence for the experimental group.

The effects of the training, although not striking in their magnitude, were sufficient to be observed even though the training was relatively short. Intensive training of longer duration would probably have a stronger effect. Apparently training in routine, systematic categories of behavior can serve to support cognitive processes. For example, requiring that Ss verbalize multiple causal hypotheses necessitates that the individual activate associative retrieval processes in order to generate the hypotheses. Remote association has often been connected with creative thinking and creative thinking with problem-solving and inquiry. Further, training in strategic behaviors can help the individual to avoid interference from such problems as set. In considering the alternative approach of teaching and encouraging problem-solving exclusively through familiarity with problem content structure it might be well to note that set can be a function of undo expectation of constant problem structure. Undoubtedly, familiarity with basic information and organizational structure is a necessary condition for competent inquiry. It is the contention of this writer that such familiarity is not a sufficient condition. One might attribute the proliferation of programs to teach problem-solving in the abstract as a reaction to the more traditional means which tended toward specialized application of systematic inquiry and thought.

Inquiry has typically been fostered by repeated exposure to defined problems within a discipline, however, it might be more effective to teach it as a set of abstract routines which function to support and enhance mental processing in a wide range of fields. The potential benefits to such pursuits as science, teaching, and medicine and simple daily living of improved problem-solving skills can hardly be denied.

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